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THE LIFE HISTORY OF THE EVERGLADES RAT SNAKE, *ELAPHE OBSOLETA ROSSALLENI*

By E. ROSS ALLEN and WILFRED T. NEILL

Little has been published concerning the habits of the recently described Everglades rat snake, *Elaphe obsoleta rossalleni* Neill. Being especially familiar with the form, we herewith present our observations.

The range of the Everglades rat snake has been given as northern Monroe and Dade counties; Collier, Broward, Palm Beach, Hendry, Lee, Charlotte, and Glades counties; extreme southern Sarasota County; and probably Martin County, Florida (Neill, 1949; Herp. 5, 2nd supplement: 3). Thus the greater part of the range lies within the Everglades and the adjoining Big Cypress Swamp. Within this area the form seems to reach its maximum abundance in northern Broward and southern Palm Beach counties, in the Everglades. A brief description of this region will be given.

The area near the western end of the Broward-Palm Beach County line is mostly one of saw-grass marsh, the characteristic habitat of the Everglades. Here the saw-grass (really a sedge, *Cladium jamaicensis*) stretches monotonously for mile on mile. Farther east, the saw-grass marsh is interspersed with numerous clumps and thickets of wax-myrtle (*Myrica cerifera*), and beyond that one encounters marshy "prairies"—areas overgrown with grasses and forbs that can tolerate considerable fluctuation in water level. Eastward of the "prairies" are more saw-grass marshes, wax-myrtle thickets, deep water holes, cypress stands, and finally salt marsh.

In this region, the rat snake's choice of habitat is as varied as the Everglades itself. The herpetologist who is familiar only with the more northern subspecies of *E. obsoleta* may be surprised to find *E. o. rossalleni* in the well-nigh treeless saw-grass marshes. It is even more surprising to find the snake in abundance about the "prairies", which fluctuate between the extremes of flood and drought, and where the only shelter from the blazing sun is an occasional palmetto clump. Everglades rat snakes are also commonly found in wax-myrtles over water, and upon the branches of trees and shrubs bordering canals and roadways. Many are discovered by night in the "Australian pine" trees (*Casuarina equisetifolia*) which have been planted along the highways in the area; others are found in roadside sheds, and also in the vicinity of bridges, where they secrete themselves in crevices between the road-bed and the bridge supports.

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A captive female *E. o. rossalleni* deposited 21 eggs on August 6, 1949. Three of the eggs were unusual in being pointed at one end, and also in being noticeably larger than any of the remainder, measuring 44.3 by 23.7, 42.4 by 24.4, and 43.5 by 24.1 mm, respectively. One of the eggs was unusually small, measuring only 28.7 by 19.7 mm. The remaining 17 eggs ranged in length from 30.1 to 38.8 mm, average 34.3 mm; and in diameter from 19.1 to 23.0 mm, average 21.1 mm. The egg shells were mostly smooth and whitish in color, but bore light purplish mottlings upon which small granules or crystals could be seen. Apparently calcification of the shell was incomplete in this instance.

Available for comparison was a clutch of 41 eggs deposited by a female *E. o. quadrivittata*. These eggs were smaller than those of *E. o. rossalleni*, the length ranging from 30.0 to 38.6 mm, average 32.5 mm; and the diameter from 18.0 to 21.1 mm, average 19.5 mm.

On several occasions the eggs of *E. o. rossalleni* were discovered in the wild, buried beneath leaves and debris on canal banks or islands—places generally affording protection from rising waters.

The various subspecies of *E. obsoleta* are mostly quite similar when young, and juveniles sometimes can not be allocated except upon a geographic basis. This however, is not true of *E. o. rossalleni*, the young of which are readily identifiable from the time of hatching. A typical juvenile, taken at Clewiston, Hendry County, Florida, is described below.

Snout-vent length 262 mm; tail length 59 mm. Ground color, above, light pinkish-buff. Dorsum with 31 blotches of light grayish-brown, edged with darker brown; the first three of these blotches H-shaped, the remainder more or less rectangular, wider than long. Sides with smaller blotches, in alternation with the dorsal series. Tail, above, with 18 grayish-brown transverse bands formed by a confluence of dorsal and lateral markings. A grayish-brown stripe, somewhat ill-defined, extending from the posterior margin of the supraocular backward to a point just beyond the angle of the jaw. A brownish stripe, not sharply defined, between the eyes, following the anterior border of each supraocular and the suture between the frontal and the prefrontals, and sending a blunt extension anteriorly along the suture between the prefrontals. A small, round spot of grayish-brown on the posterior end of each supraocular; a similar but slightly larger spot on each side of the head in the temporal region. A dark brown, vertical dash from the ventral margin of the eye to the edge of the jaw; three similar but smaller dashes anterior to this, on the sutures between the supralabials. Throat white; venter light yellowish-brown with pale grayish-brown mottlings which form tessellations anteriorly and an irregular mid-ventral line posteriorly. Iris light pinkish-orange; tongue sepia.

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From the above description, it is evident that the young of the Everglades rat snake displays the same basic pattern as the young of other subspecies of *E. obsoleta*. In the relative obsolescence of the head markings when young, *E. o. rossalleni* resembles *E. o. quadrivittata*. The light pinkish-orange or pinkish-buff ground color of the young *E. o. rossalleni* foreruns the brilliant orange of the adult, and is unique among the subspecies of *E. obsoleta*.

In Everglades rat snakes of about 600 mm length, the dorsal and cephalic markings have nearly or quite disappeared, stripes are evident, the

dorsum is orange, and the venter is orange-yellow. Ontogenetic color change is exceptionally rapid in this subspecies.

We have no exact data on growth rate, but suspect that it is rapid, since the form is active for 9 months of the year, and usually inhabits areas where food is abundant. The Everglades rat snake is one of the largest subspecies of *E. obsoleta;* 5- and 6-foot examples are not rare, and 7-foot examples are occasional.

Young specimens of *E. o. rossalleni* have been observed to feed upon tree-frogs, cricket-frogs, young leopard frogs, anoles, and ground skinks. The adults were found to prey upon rice rats, cotton rats, various mice, young marsh rabbits (which are very abundant in the rat snake's habitat), various passerine birds and their eggs, young wild ducks, hens' eggs and baby chicks, and young cottontail rabbits. A small shrew of unidentified species was also found in one stomach.

In times of flood, when vast numbers of rodents are driven to the islands and canal banks, the rat snakes glut themselves, and often find it necessary to regurgitate some of their prey. On one occasion several regurgitated mammals were found in an old shed where the snakes had been feeding.

These rat snakes capture their prey in much the same fashion as do other forms of *Elaphe.* First there is a cautious stalk, then a sudden strike; in an instant the prey is drawn beneath the snake and enveloped in two or three constricting coils. The prey chokes to death in a few minutes, and is swallowed head first. Captive specimens were sometimes observed to fight over the same rat, but one always withdrew in time to prevent being swallowed by the other along with the prey.

Everglades rat snakes have been noted to climb telephone poles and enter woodpecker holes, doubtless in search of birds or eggs.

These rat snakes seem perfectly at home in the water. On the surface they swim rapidly, with part of the body submerged. Along the canals they sometimes dive off tree limbs when disturbed and disappear beneath the surface, swimming a considerable distance under water and emerging at the opposite bank. Their aquatic tendencies serve them in good stead when the cattlemen burn off the "prairies". At such times, the rat snakes make their way to the nearest water, where they remain until the fire has passed.

Courtship antics were noted in a cage of captive specimens. Sometimes two or three snakes, lying atop several others, would make spasmodic, jerking movements, looping their bodies across the snakes beneath them and waving their tails about excitedly. On several occasions, when the female snake was resting on a tree limb, the male would wrap his neck about hers. Most of the time courtship took place on the floor of the cage, however. It was interesting to note that individuals of *E. o. rossalleni* made little attempt to court specimens of *E. o. quadrivittata* in the same cage. Occasionally Everglades rat snakes would begin to court yellow rat snakes, but would immediately desist and turn their attention to individuals of their own subspecies.

In the wild, *E. o. rossalleni* has a number of known enemies. Ward's heron, the wood ibis, and the night herons have all been observed to feed upon the smaller snakes. Alligators and indigo snakes prey upon both young and adults. Egrets, owls, otters, and turtles are potential ene-

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mies, and doubtless exact some toll. Hundreds of Everglades rat snakes, basking on paved highways, are crushed by passing automobiles. Like most snakes, *E. o. rossalleni* harbors parasitic worms in the digestive tract; some captive examples die of these infestations. Occasional emaciated specimens are found in the wild. Many wild examples have lost a portion of the tail, and large adults often bear numerous scars on the body.

Everglades rat snakes are fairly docile in captivity, but can be provoked into striking. Angry specimens draw the anterior portion of the body into one or more S-shaped curves, elevating the head and sometimes opening the mouth. From this position they lunge forward, often accompanying the strike with a short hiss. Like other rat snakes, they vibrate the tail rapidly when annoyed, and, if grasped, will void the contents of the anal glands.

The above observations suggest that *E. o. rossalleni* is a form specifically adapted for life in the Everglades or regions of comparable habitat. Possibly as a result of its thorough adaptation, it is a common snake throughout much of its range. Thus, during the course of one night's canoe trip, 47 specimens were found lying in the branches of trees along a canal bank. Recently a professional collector brought 200 specimens to the Reptile Institute; other large consignments have been received in the past.

Research Division, Ross Allen's Reptile Institute, Silver Springs, Florida

RHINOCHEILUS LECONTEI TESSELLATUS GARMAN IN TAMAULIPAS, MEXICO.—The eastern long-nosed snake, *Rhinocheilus lecontei tessellatus* Garman, heretofore has been recorded in Mexico only from the states of Coahuila and Nuevo Leon (Smith and Taylor, U. S. Nat. Mus. Bull. 187, 1945, p. 121), although its occurrence in the narrow strip of extreme northwestern Tamaulipas certainly was to have been expected. *R. l. tessellatus* is abundant in southern Texas immediately to the north of Tamaulipas, where it is second only to *Arizona elegans elegans* as the most commonly observed D.O.R. snake, and one specimen has been reported from adjacent Nuevo Leon at a point forty miles south of Laredo (Klauber, Trans. San Diego Soc. Nat. Hist., Vol. 9, No. 29, 1940).

On July 18, 1949, a female of this subspecies was collected just off the Pan-American Highway, three miles south of Nuevo Laredo, in arid mesquite country. The snake was found at night with the aid of a flashlight as it crawled through limbs at the base of a small mesquite shrub.

This specimen, which is number 415 in the San Antonio Zoological Society collection, has a total length of 536 mm. and tail length of 78 mm, and shows the following scale characters: ventrals 181; caudals, 1 divided, 29 entire, 1 divided, 1 entire, 18 divided; scale rows 25-23-19; upper labials 8-8; lower labials 9-9; preoculars 1-1; postoculars 2-2; temporals 2-3, 2-3. Coloration and pattern are well within the normal described for this form.

Another specimen (D.O.R.) was seen in the same area several months earlier, but not preserved.—John E. Werler and Donald M. Darling, San Antonio Zoological Society.

REPTILES AND AMPHIBIANS IN URBAN AREAS OF GEORGIA

By WILFRED T. NEILL

The great hardwood forest that once covered Georgia has largely disappeared, having been replaced by barren red-clay fields and stands of scrubby pine. With the forest have gone many of the animal species, following the trail blazed by the Carolina parakeet and the passenger pigeon. The wholesale destruction of natural resources, far from abating, has even accelerated in recent years; and yearly the naturalist must go farther afield for specimens. It is therefore gratifying to the herpetologist to note that a surprisingly large number of amphibians and reptiles have become adapted to city life, often being abundant even in thickly populated sections.

Many amphibians and reptiles are common about farms, out-buildings, wood-lots, etc. Such forms are not included in this article, which deals only with those species of frequent occurrence about homes, lawns, streets, public buildings, and the like. Within these limits three groups of species may be more-or-less arbitrarily defined. First are those forms that maintain themselves in areas of paved roads, concrete sidewalks, factories and office buildings - truly urban areas where vegetation and natural surroundings are entirely lacking. Second are those forms that live about residences and small lawns, where some little cover is available in the form of grass or shrubbery. Third are those species occurring in vacant lots, large lawns and gardens, or small wooded areas completely surrounded by dwellings. Most of the following observations were made in Georgia at Athens (Clarke County), Atlanta (Fulton and DeKalb counties), and particularly at Augusta (Richmond County).

GROUP 1. *Elaphe g. guttata.* The corn snake is astonishingly abundant at Augusta. This city, like many other southeastern ones, swarms with rats whose tunnels riddle the ground beneath almost every building. In these tunnels, and in old water mains, storm sewers, and abandoned pipe-lines the corn snake abounds, leading a thoroughly subterranean existence. Six specimens were collected and many others seen in the underground watermeter installation of a large hotel; eight others were taken in the basement of a church; two were found in the basement of a factory in the heart of the industrial section; another turned up in the furnace room of an office-building. Two were unearthed when a building was razed in the business district; three were washed from beneath the concrete floor of a parking-lot when a hose was inadvertently left running; workmen digging out house foundations unearthed specimens on at least seven occasions. Whenever a water main bursts or a water tower overflows, several corn snakes are likely to be washed from their subterranean retreats. Specimens are often disclosed when concrete garage floors are torn up. After each outbreak of typhus fever, rat-killing campaigns are begun; poison gas is forced down the more conspicuous rat burrows, often routing quite a few corn snakes along with incredible multitudes of rats. Each autumn the young of the corn snake turn up throughout the city, finding their way into front parlors, pantries or other places. Great numbers are run over by automobiles and many others are killed by gardeners raking leaves or tending

rock gardens. In spite of this destruction the species remains inordinately abundant; far more specimens can be collected in the city of Augusta than elsewhere in the surrounding region. Corn snakes were also found in Savannah (Chatham County) and in several smaller towns in South Carolina.

Storeria dekayi wrightorum. DeKay's snake persists in the heart of the business district of Augusta. A small colony lived beneath old newspaper and other trash on a concrete substratum behind a motion-picture theater. Other specimens were found beneath tin cans and rubbish in factory yards. However, the species is primarily a member of the succeeding group.

GROUP 2. *Scaphiopus h. holbrookii.* The spade-foot toad is common about lawns and gardens in Augusta, where it leads a subterranean existence. It breeds in goldfish ponds, often disturbing the citizenry with its raucous calls.

Bufo t. terrestris. The southern toad is more abundant than the spade-foot, or at least more frequently seen about lawns and gardens in residential areas of Augusta. Specimens often congregate at night beneath street lights, apparently to eat the insects found in such places. Throughout the spring and summer months the call of the species may be heard almost anywhere in the residential section. Some specimens find goldfish ponds in which to breed; others call even though no water is available. Individuals have definite retreats, often beneath porch steps, from which they emerge at dusk. Watering a lawn will often bring them out. The toads hibernate by digging into the ground to the depth of a foot or more.

Bufo woodhousii fowleri. Fowler's toad, like the preceding species, is common about streets and lawns, displaying much the same habits as its congener. Specimens made their way into large open reservoirs of the Augusta water-works, and soon produced a great colony of toads. More than 200 were collected during one night. The species was also observed at Athens.

Rana catesbeiana. Bullfrogs are surprisingly common in the residential sections of Augusta, where they live about goldfish ponds. Their method of reaching these ponds is of interest. Much of Augusta was once low and swampy, with many little spring runs. Large areas were rendered habitable only by diverting these streams into culverts and long pipe-lines that carried the water into a canal or into the Savannah River several miles away. Rain-water drains were turned into the same pipelines. The bullfrogs follow these underground waterways, to pop up at any convenient opening. One summer night, in an exclusive residential section, I saw a large bullfrog hop out of a drain and make its way unerringly across a spacious lawn to a goldfish pond, where it remained for several months. The following year I saw another bullfrog—or perhaps the same one—and a large red-bellied water snake emerge from this same drain; both also went directly to the fish pond. The drain opened into a creek nearly a mile away. In the summer of 1947 a bullfrog turned up in a large, rock-bordered goldfish pond near my home. Shortly thereafter the frog was joined by two others, and their croakings filled the air nightly. My neighbor (who claimed they ate his goldfish) attempted to eradicate them; but the frogs, several

times disturbed, became very wary, hiding beneath submerged and concrete-embedded rocks when approached. Nothing was seen of them during the winter; but in the spring of 1948 no less than five bullfrogs were croaking about the pond. At present they are still there; my neighbor is experimenting with rat traps. The largest bullfrog I have ever collected was an unwelcome visitor in a suburban goldfish pond. The subterranean drains are probably frequented by a number of animals; I have several times seen musk-rats emerge from them in the business district of Augusta.

A large concrete swimming pond was constructed on the outskirts of Augusta, and provided with a constant flow of purified city water. Bullfrogs found their way there from a nearby creek; their tadpoles and those of *Bufo t. terrestris* soon became common.

Anolis c. carolinenis. The "chameleon" is often seen in the shrubbery about homes and buildings in Athens, Atlanta, and Augusta.

Elaphe o. obsoleta. Occasional specimens of the black rat-snake are met with about lawns and houses. The species is much rarer in such surroundings than the corn snake, however. Black rat-snakes live beneath buildings, resting upon the stringers and joints; and also inhabit hollow trees, ivied walls, and occasionally the attics of deserted houses. The species was taken in Athens and Augusta.

Cemophora coccinea. The scarlet snake maintains itself in areas of sandy soil in Augusta. Specimens are often unearthed by workmen digging out house foundations. Dead examples are often seen in the streets in residential areas.

Natrix e. erythrogaster. As mentioned previously, the red-bellied water snake utilizes the subterranean drainage system of Augusta. One night I saw a very large, gravid female of this form emerge from a drain and make its way to a goldfish pond where, a few days later, it gave birth to a large litter. Many of the young were killed in nearby yards, but the female took up residence in a pile of rocks, overgrown with lilies, at the edge of the pond. I saw the snake several times during succeeding months. The goldfish speedily disappeared, and the owner, attributing the disappearance to cats, obligingly provided more fish at regular intervals. The following year I caught a medium-sized male of the species at the same pond; it was too large to have been one of the previous year's brood. I have several other records of the form turning up about ornamental pools in Augusta.

Group 2 includes *Elaphe g. guttata* and *Storeria d. wrightorum.*

GROUP 3. *Hyla squirella.* The quacking notes of the squirrel-frog may be heard from overgrown lots and wooded patches in Augusta.

Ophisaurus v. ventralis. A large colony of "glass-snakes" is found in a vacant lot in Augusta. Large numbers are killed yearly. Newly hatched young appear each year; and many adults have been collected. The species was also taken in Savannah.

Eumeces laticeps. A remarkable colony of the red-headed skink was noted about a weedy patch in a railroad yard at Athens. Here the lizards were present in great numbers, and reaching an unusual size. There was nothing for them to climb save three telephone poles, and the animals were not noted to utilize these. Instead, they lived beneath the scant shelter of empty oil drums and scraps of tar paper. The whole ar-

ea was covered thickly with dust stirred up by nearby traffic. The colony included fully 75 *E. laticeps* and a few *E. inexpectatus*.

Heterodon p. platyrhinos. The hog-nosed snake occurs in dry, sandy lots in Augusta. Adults are seldom seen, but young-of-the-year turn up regularly. Many are run over by automobiles. I once found the nest of this form in a patch of hot sand at the base of a cactus plant in a vacant lot.

Opheodrys aestivus. The keeled green snake persists in wooded lots in Athens, Atlanta, and Augusta, usually in thickets of honey-suckle (*Lonicera japonica*).

Haldea v. valeriae. A large colony of Valeria's snakes was found beneath tar paper and other rubbish in a vacant lot in Atlanta.

Terrapene c. carolina. The above-mentioned vacant lot in Atlanta also yielded a few box turtles. The species occurs in the suburbs of Augusta.

Group 3 includes all the members of the preceding groups, with the exception of *Rana catesbeiana* and *Natrix e. erythrogaster,* which are confined to goldfish ponds, and of *Elaphe g. guttata,* which prefers the immediate vicinity of buildings where rodents abound.

A fourth group or subdivision might include those forms that are thoroughly aquatic, occurring in ditches and canals in urban areas. This group includes the "lamp-eel", *Amphiuma means,* and the mud turtle, *Kinosternon s. subrubrum,* both of which have been taken in Augusta.

Research Division, Ross Allen's Reptile Institute, Silver Springs, Florida.

THE SHARP-TAILED SNAKE IN BRITISH COLUMBIA

By G. CLIFFORD CARL

The range of the sharp-tailed snake, *Contia tenuis* (Baird and Girard), is given in recent check-lists as south central California to Puget Sound. An old record of its presence in British Columbia is given by Van Denburgh (Reptiles of Western North America, Vol. 2, pp. 771-773, 1922) which is based on a specimen taken on Vancouver Island between the dates 1857 and 1861 by Dr. David Lyall, surgeon on H. M. S. "Plumper" and listed by Boulenger under the name *Contia mitis* (Catalogue of the Snakes in the British Museum, Vol. 2, p. 268, 1894). Presumedly later workers have chosen to await confirmation of this record or have overlooked it since it is not included in recent check-lists.

Lately however, the presence of this snake in this Province has been confirmed by the taking of three specimens on North Pender Island, one of the numerous Gulf Islands bordering Georgia Strait.

The details of the British Columbia specimens are as follows:

Number	Date	Body	Tail	Ventrals	Caudals	Collector
e	1857-61	275mm	40mm	161	29	Dr. D. Lyall
856	5-7-49	196	37	152	35	Mrs. B. J. McGusty
859	23-8-49	197	37	152	34	Mrs. Allan Brooks
875	25-6-50	128	23	155	36	Mrs. Allan Brooks

I am indebted to Mrs. McGusty and Mrs. Brooks, both of Pender Island, for donating their specimens to the Museum and to Mr. H. W. Parker, Keeper of Zoology at the British Museum of Natural History, London, for information concerning the specimen in their collection.

Provincial Museum, Victoria, B. C.

A NEW SNAKE (*TANTILLA*) FROM MEXICO*

By HOBART M. SMITH AND LESLIE BURGER

Among the reptiles and amphibians secured by the junior author and his brother in Mexico during the summer of 1949 is a series of six snakes representing a very distinct, undescribed and unnamed species of *Tantilla*. We are indebted to the Graduate Research Board of the University of Illinois for providing funds for the trip, and to Dr. D. F. Hoffmeister for critical perusal of this manuscript and for providing equipment and facilities for collecting and study.

Tantilla flavilineata sp. nov.

Holotype. Univ. Ill. Mus. Nat. Hist. No. 6321, an adult female from a locality 8 miles southeast of Nochixtlan, Oaxaca, Mexico, collected on August 23, 1949, by Jack and W. Leslie Burger. *Paratypes.* Five, UIMNH nos. 6322-6, with the same data as the preceding.

Diagnosis. A *Tantilla* with two dorsolateral and a median light stripe, an uninterrupted light nuchal collar, 160-164 ventrals, 48-56 caudals. Related to, of Mexican species, *T. striata* and *T. jani*, but differing from both in number of ventrals or of caudals and in position of lateral stripe. Closely similar to *T. virgata* of Costa Rica, having dark and light stripes of approximately equal width, but ventrals and caudals less numerous.

Description of holotype. Frontal hexagonal, its length exceeding its distance from tip of snout by nearly ½ of latter; maximum width of frontal exceeding maximum width of supraocular by ½ of latter; sides of frontal convergent posteriorly; maximum length of internasals 2/3 maximum length of prefrontals; common internasal suture about 1½ times as long as common prefrontal suture; common parietal suture ¾ length of frontal. Nasal large, constricted to a width little more than that of nostril at position of latter, completely divided, in contact with preocular; 1 preocular, 2 postoculars; lower postocular separated from parietal by 1/3 length of posterior border of upper postocular; two temporals, an anterior and a posterior, both about twice as long as broad; eye separated from lip by about 2/3 its own vertical diameter, and from tip of snout by about twice (or slightly more) its horizontal diameter. Seven supralabials, last much the largest, each at least a little larger than the preceding. Mental with a labial border slightly exceeding that of rostral, ½ as long as wide at labial border, separated from chinshields by 1/5 its length; 6 infralabials, the anterior in contact with its mate medially, 4th much the largest, the anterior four in contact with anterior chinshield, only the 4th with posterior chinshield; latter 2/3 length of former and somewhat narrower.

Dorsals in 15-15-15 rows, smooth, with no apical pits; ventrals 162; anal divided; caudals 51, divided.

Total length 300 mm., tail 57 mm.

Dorsal surface a light tan, each scale darker centrally than laterally, especially at posterior tip, giving the impression, upon close inspection, of a dotted or dashed line down each scale row.

Top of head darker brown, reticulated laterally with black; snout lighter above forward from middle of prefrontals, but lower surface of

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*Contribution from the University of Illinois Museum of Natural History

rostral very dark brown; sides of head light from labial border to lower edge of nasals, and to near lateral tip of parietal, with an extension of the dark dorsal color around the eye on the upper part of labials, 2, 3, and 4; 1st and 5th supralabial completely white; another extension of black from the dorsal surface reaches the labial border on the 6th and 7th supralabials, involving the rear ½ of the former and all except the rear tip of the latter. A dark pigmentation on the labial border of the anterior 5 infralabials, little exposed as the lower jaw is closed.

Nuchal collar white, little more than 1 scale in length, involving very little of the tips of the parietals, bordered posteriorly by a straight transverse line of dark brown spots. On body, three broad light stripes separated from each other by dark areas (stripes) of a width equal to that of light stripes and not greatly (although notably) darker than light stripes; a light tan vertebral stripe, becoming white posteriorly, occupying the median scale row and edges of adjacent rows, bordered laterally by a narrow dark brown streak occupying the middle of the paravertebral scale rows, continuing to tip of tail. A light tan dorsolateral stripe on 4th and edges of adjacent scale rows, its lateral border defined (on middle of 3rd scale row) by a dark brown streak as dark as those on paravertebral rows, the medial border not or but little darker than the ground color occupying the 5th and ½ of each adjacent scale row; sides below 3rd scale row nearly uniform tan, with a faint light streak along adjacent edges of 1st and 2nd scale rows; only lateral tips of ventrals pigmented, the pigment concentrated at anterior edge, concealed by preceding ventral.

Variation. The paratypes closely resemble the holotype, and demonstrate remarkably little sexual dimorphism. Certain scale counts and measurements are indicated in the accompanying table. The mental contacts the chinshields in one; the prefrontals are separated from the labials in all; the posterior temporal is split into 2 scales in one. All have 7-7 supralabials, 6-6 infralabials, 1-1 preoculars and 2-2 postoculars.

There is little significant variation in pattern. The holotype is, however, the lightest of the series; the others are somewhat darker. The vertebral light stripe, which unites with the nuchal collar in the holotype, is separated from it by a continuous black posterior border of the collar in two paratypes. The head markings are remarkably constant. The lateral light stripe is not visible on the tail, and in fact its lateral dark border, clearly evident on the body, abruptly disappears just in front of the tail.

The largest male (No. 6324) has 12 - 2 maxillary teeth, and the two rear fangs are deeply grooved and about 2½ times as long as the preceding teeth; the diastema is about 2½ times the length of the base of the 10th tooth. Two peculiarities are evident: a pair of rather large foramina pierce the upper part of the maxilla above the 5th, 6th and 7th teeth, and the posterior tip of the maxilla forms a process closely resembling one of the fangs.

Hemipenis, of No. 6324, 8-9 caudals long; a basal area ridged and with tiny spines distal to 6th caudal on antisulcus side, to 4th on sulcus side, where large spines extend proximally into the zone of small spines; a belt of large spines about 1½ caudals long, narrower by 1 cau-

dal on anti-sulcus side; remainder of hemipenis covered by papillate calyces, the calyces decreasing markedly in size toward apex, the papillae increasing in size sulcus simple; apex not divided or only slightly bilobate.

Comparisons. *Tantilla flavilineata* appears to be a very distinct species, belonging to a group which in Mexico includes only the species *striata* and *jani*. From *jani*, the present species differs in number of ventrals (160-164 *vs.* 139-154), width of vertebral stripe (one complete and two half rows *vs.* one complete row), position of dorsolateral stripe (one complete and two half rows on 3, 4 and 5 *vs.* two half rows on 3 and 4) and in other minor features of the body pattern.

From *striata* the present species differs in number of caudals (48-56 *vs.* 34-42), character of nuchal collar (complete *vs.* two isolated spots), position of dorsolateral stripe (as in *jani*), and in other minor features both of pattern and scutellation.

It is not obvious that *flavilineata* is more closely related to one of these species than the other; it combines certain distinctive features of each and adds some unique characters. Actually, its closest relative appears to be *T. virgata* (Costa Rica) which has a remarkably similar pattern. As a matter of fact, Gunther's figure (Biol. Centr. Amer., 1895, pl. 52, fig. A) matches almost perfectly the pattern of *flavilineata*. In *virgata*, however, both the ventrals and the caudals are more numerous, except for one specimen recorded by Boulenger (Cat. Snakes Brit. Mus., vol. 3, 1896, p. 223) with 154 ventrals and 57 caudals. Boulenger's other specimens are recorded with 167-175 ventrals and 59-63 caudals (Gunther, *op. cit.*, p. 154, records 180 ventrals and 71 caudals for one of the same specimens, presumably the type!), and accordingly we conclude that the aberrant count is either in error or is of a specimen representing a different species. Certainly there is no question of the difference in both ventrals and caudals between typical *virgata* and *flavilineata*.

Homalocranium sexfasciata Fischer (Abh. Nat. Ver. Bremen, vol. 7, 1882, p. 225, pl. 14, figs. 8-10; Costa Rica) appears to be a junior synonym of *T. virgata;* it has 165 ventrals and 65 caudals, extending the limits of Boulenger's hypodigm only slightly to give a total range of 165-175 (180?) in ventral count, and 59-63 (71?) in caudal count for the species.

Variation in Paratypes of *T. flavilineata*

Number	Sex	Ventrals	Caudals	Total Length	Tail Length
6322	F	164	48	132	23
6326	F	161	49	197	37
6325	F	162	49	277	52
6323	M	160	51	242	46
6324	M	160	56	287	58

SEXUAL BEHAVIOR IN TWO MALE GOPHER SNAKES.—On a field trip June 4, 1950, to Ibapah, Tooele County, Utah, two male gopher snakes (*Pituophis catenifer deserticola*) were observed in activities which were later interpreted as attempted copulation. When first observed by Dr. W. H. Behle, Richard D. Porter, Robert K. Selander and myself they were under a greasewood bush. The larger male snake, about 40 inches in length and light colored, was holding with his mouth a smaller dark colored male about 35 inches in length.

The smaller snake was vigorously thrashing its body back and forth in an effort to escape while the larger one was throwing body loops over it in an effort to make it hold still. During the operations their bodies were free except for the neck hold of the larger snake and for the four or five tight twists that were anterior to their cloacal regions. Whenever the cloaca of the larger snake approached that of the other, the smaller snake reacted violently in a wave-like body flip, anterior to posterior, which would separate them. Thereupon, the smaller snake made a dash to escape, being rapidly followed by the larger snake which grasped the fleeing individual near the middle of the body and stopped his flight. By successively quieting the smaller snake and grasping him farther forward he worked his hold up to the neck, whereupon the looping and entwining of the bodies was started again.

This cycle was repeated three times while being watched at close range (3 to 5 feet) without any apparent interference in the proceedings because of our presence. At the end of the third cycle, the smaller one actually escaped. The larger snake then commenced to actively search the area.

The smaller snake, which we suspected of being a female, was caught and found to be a male. The other snake was then captured and examined and also proved to be a male. When held together by their tails and then later released on the ground together, neither snake showed any interest in the other.

Sex activities between two males and a female of this species have been described by A. M. Woodbury (Copeia, 1941:54) in which two males were struggling with each other while each was trying to copulate with a passive female.

D. Dwight Davis (Zool. Ser. Field Mus. Nat. Hist., 20, 1936:283) reports that sex in snakes is recognized directly through olfactory stimulus. What is normal behavior of copulating pairs? Is sex recognition based on smell or behavior alone, or is it a combination of many factors? Until we have more field observations reported such questions will remain unanswered. Richard M. Hansen, *Dept. Vert. Zool., University of Utah, Salt Lake City, Utah.*

A POSSIBLE INSTANCE OF TRAUMATICALLY ACCELERATED ECDYSIS IN *THAMNOPHIS*

By D. F. MUNRO

Concerning the question of stimulation of the rate of shedding in snakes by injury (Neill, *Herp.* 5:45, and Perkins, *Herp.* 6:17) the account to follow may be of interest.

The record, complete since February, 1947, of a female *Thamnophis ordinatus parietalis* caught in maturity in May, 1945 (Munro, *Herp.* 4, 185ff), shows the following dates of shedding, up to and including the most recent:

1945 - 3 (?) sheddings }
1946 - 4 (?) sheddings } early records unfortunately missing.

1947 - Feb. 28; May 15; July 2; Aug. 13; Sept. 10 (a hot summer.)

1948 - May 11; Aug. 18; Nov. (date uncertain).

1949 - May 27; Aug. 21 (a cool summer).

1950 - July 11; Aug. 15 (a still cooler summer).

The snake has seemingly almost ceased growing in length and weight, which may explain in part the longer intervals between sloughs in the later years, with the exception of the very last interval, the subject of this note.

A week or so before the shedding of July 11, 1950, a pus-formation of unassigned causation originated behind and above the right eye. It was not treated, in view of the imminence of ecdysis, for assumably it would pass off with the slough, as is usual in such cases. But after ecdysis, the pus-filled blister was seen to be *under the new skin;* in the next few days it invaded the area of the ocular scale, and in the course of two weeks it gradually obscured the eye. Treatment with potassium permanganate solution did not seem to be of help, and was suspended after a brief trial.

By the first of August the white, opaque pus finally covered the eye to such an extent that the snake had evidently lost the sight of that organ, for she made none of her customary responses to sudden movements or flashes of light on that side, whereas such stimuli on the left evoked the usual reactions—flicking of the tongue and alert lifting or turning of the head.

Because of her past history of shedding, it appeared that the snake was to spend two or three months with monocular vision, much to her discomfiture, it seemed, for she often rubbed the blinded eye against objects, as if to clear it.

Keeping the snake warmer than usual and feeding more abundantly might conceivably have caused earlier shedding than what appeared to be "scheduled", namely, about the end of September or early in October. But it was not practicable to try either method, for 1950 was a cool, wet summer in Kansas, and the snake always regurgitated

much semi-digested food if fed in excess or too often, so that only normal feeding could be carried on.

Very welcome, then, were the surprisingly early indications of another shedding, far sooner than could have been expected. The skin color became dull, the left (good) eye clouded up, and at the same time all the scales surrounding the troubled right ocular seemed to lift from the sub-skin, turned white, and appeared to be floating over a layer of pus. Because the infection involved the area of the eye, no attempt was made to alleviate conditions by puncturing the skin and draining off the liquid, as had been done with similar blisters on less critical parts of the body of several snakes. (These non-critically located blisters had never seemed to hasten shedding).

A day or so before the shedding, after the left eye had cleared, the pus in the affected right ocular, hitherto white and opaque, became greenish-yellow and translucent, the orb now being faintly visible; the snake at this time began to respond to visual stimuli directed toward that eye.

Ecdysis occurred with a perfect slough on August 15, only five weeks after the previous shedding, a far shorter period than this snake had displayed in several years. The ocular and surrounding scales of the right eye on the shed skin were thickened and turbid with solidified pus. The formerly blinded eye was now bright and clear, as of old.

Since there had been no fundamental change in the conditions of the snake's life, it seems probable that the infection involving the right eye so seriously (thus constituting an organically very important impairment, comparable to a grave injury) was the factor responsible for the unusually short interval between the two recent sheddings by this elderly serpent.

(The snake has not shown any signs of her next shedding, two and a half months since the above was written.)

Kansas State College, Manhattan, Kansas

INCUBATION AND HATCHING OF EGGS OF *COLUBER C. FLAVIVENTRIS*

By D. F. MUNRO

On July 4, 1948, a large *Coluber constrictor flaviventris*, captured on May 12, laid 14 eggs, varying in weight from 7.8 to 4.8 gm., and a small *C.c.f.*, captured on June 23, laid 5 fairly uniform eggs, 7.1 to 6.5 gm., as previously reported (Herp., 4:199).

The eggs were first kept on moist sand in glass containers with tight-fitting lids, which were removed occasionally for short periods. This method had been used previously with success. But this time, beginning about July 10, the eggs began to collapse, one by one. There seemed to be no connection between size of egg and order of collapse; rather, an egg, large or small, would collapse at random, with the notable exception that the 5 eggs of the small snake were the last to show evidence of impending failure.

On July 21 the eggs were transferred from sand to a new medium: damp paper towels under a folded dry one. After a day or so, improvement was noted in one or two of the most recently collapsed eggs,

and after a week, six of the initial 19 had regained their original plumpness and were ostensibly on the way to hatching.

It was at first believed that the collapse of an egg meant that the embryo had died, and that therefore no sacrifice of a little snake would be involved in opening the egg; later evidence indicated that the eggs had survived the earlier stages of dessication and that some of those which were opened probably would have produced young.

In the following paragraphs, unless otherwise stated, the eggs are of the large Blue Racer's clutch of 14.

July 11. A week after being laid, the first egg to suffer showed two deep dents, and on being opened, it was found to contain a yellowish-gray, slightly sirupy fluid and a layer of whitish rubbery substance adhering to the wall of the egg; there was a tiny speck of red on the surface between the fluid and the rubbery layer.

July 14. The second collapsed egg was opened; it looked like the first one, except that the rubbery layer was thicker, and the spot of red larger.

July 15. Two eggs had collapsed; each showed two small red areas between the fluid and the layer.

In these four eggs there was no visible trace of the form of a small snake.

July 21. An egg that had collapsed on July 16 was almost completely dried out, the interior being a stiff waxy mass. The first egg from the small clutch of 5 was now opened. It had become badly dented, but contained a curled-up embryo with a large head, very prominent black eyes, and a white, gelatinous, translucent body with no indication of scalation or pattern. Minute red blood-vessels ramified through the rest of the egg. The embryo was 8.5 cm long, and evidently alive, for watery blood seeped from the egg and the embryo when the latter was straightened out for measurement.

July 28. Several eggs were opened, including two from the small clutch. None of them had regained rotundity despite transfer from sand to the more favorable medium. They had become discolored to a dirty yellowish-brown, and their interiors were found to have much the consistency of the white of a hard-boiled hen-egg or of a lump of tallow; those from the large clutch contained no embryo. In each of the eggs from the small clutch was an embryo, one clearly showing the characteristic large dark eyes, the other being less developed. The lack of fluid in the eggs and the small size of the embryos, compared with that disclosed on July 21, indicated that they had long since ceased to grow.

August 3. The largest of all the eggs, which had apparently recovered upon transfer from sand, but which had begun to collapse again after a week, was found to contain a dead embryo in an early stage of development, the eyes not yet visible.

August 13. Another large egg which also had collapsed after apparent recovery contained an embryo with large black eyes. It was about 5 cm long, but could not be entirely straightened out, because there were four or five kinks in the body. Its small size and the fact that it did not bleed showed that it had died long before.

None of these embryos had shown any trace of color pattern, their bodies being translucent and featureless, except for the dark eyes of the more developed specimens.

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August 23, 24. Two eggs from the small clutch hatched. The young weighed 4.9 and 4.7 gm and were about 25 cm in length.

August 26. An egg which had begun to collapse for the second time contained an apparently completely developed, full-sized, but very badly deformed young snake. The body was twisted into a ball, the whole ventral surface of the rolled-up snakelet seeming to have coalesced and contracted, as if puckered by a drawstring. This individual had the normal color pattern of a young Blue Racer. It was lifeless.

August 29. The last of the eggs was opened several days after it had begun to collapse. It contained a small but completely developed snake, deformed in the same way as the preceding one.

To judge from this series of eggs, the individual Blue Racer accomplishes most of its development after the egg is laid, because none of the eggs opened before July 21 (two weeks after deposition) contained a visible embryo, even though they did show evidence that they might have produced young under less adverse conditions. The collapse of the eggs on the sand seems to have resulted from insufficient moisture. Since two of the eggs ultimately did hatch, it appears that in nature eggs could withstand rather severe hazards, such as drought, and still develop successfully.

Kansas State College, Manhattan, Kansas

JUVENILE PATTERN IN A MATURE FEMALE *COLUBER C. FLAVIVENTRIS*

By D. F. MUNRO

A small gravid *Coluber constrictor flaviventris* still distinctly showed the juvenile pattern on the sides of the head, on the labial scales, and on the ventral plates. On the head the color as well as the pattern persisted; on the yellow ventral surface, even before any preliminary stages leading to ecdysis, the spots of the pattern were of a hazy blue-brown color, appearing as if embedded under a milky film.

After the casting of the skin, the pattern did not appear to differ from what it had been prior to the cloudiness developed before shedding; the ventral blotches still looked as if they were obscured by a translucent film, and were no fainter than before.

However, when the snake was liberated a fortnight or so after sloughing, the pattern was clearly observed to have faded considerably, particularly on the ventral surface, compared to its state a month earlier. The snake was thus evidently in the last stages of the change from juvenile to adult coloration.

It would appear that the juvenile pattern fades away imperceptibly because of changes in deeper-lying tissues, rather than in distinct gradations caused by casting of the skin. The loss of the youthful pattern is not necessarily completed before sexual maturity of the individual.

Kansas State College, Manhattan, Kansas.

REVIEW OF THE CHONDROCRANIUM OF TAILED AMPHIBIA

By WILLIAM A. HILTON

The cartilaginous investment of the brain and head sense organs which is evident in late embryonic and larval stages becomes reduced in varying degrees as adult life is approached. This is much the same in all salamanders, but different rates of development and different times when maturity is reached in various species show many marked differences in the skull which are not always fundamental. Structures in specimens that are not mature often show individual differences which become more marked in the adult. Different rates and degrees of chondrofication and ossification may often, but not always be explained as periods of development. In addition to such differences there are numerous variations which may be found between species, genera and to some extent families.

In this review, larvae or immature specimens have been examined in seven of eight families and adults in all eight.

The general development is much as follows:

The notocord extending forward in the middle line as far as the infundibulum of the brain is associated with the early chondrocranium. A horizontal cartilaginous rod on each side, called parachordal plates, unite with the notocord to form the basal plate. Continued forward from the last on each side trabeculae extend to the olfactory region where each expands into a flat cartilage ventral region of the olfactory capsules which are formed later. Extending laterally from these cartilages are the trabecular horns, more or less triangular in form. The cartilage skull when well formed has two ear capsules connected by a ring of cartilage between the capsules. In varying degrees much later, the nasal capsules are formed in the anterior region of the early cartilaginous skeleton.

Some larvae in addition to the basal plate, trabeculae, otic and olfactory capsules have cartilage developed in the sclerotic coat of the eye.

As late larval or early adult stages are approached much of the original chondrocranium ossifies and in varying degrees the cartilage that remains becomes covered with investing membrane bones. So complete are these two methods of skull formation that little of the primordial skeleton is evident in the adult.

Two methods of studying this rather obscure series of structures are as follows:

1. Dissection. This is of limited value because of the difficulty of removing bones from the often delicate cartilaginous parts closely associated with them.
2. The study of serial sections of all stages.

There have been many papers on the skulls of Amphibia. One of the first was by Duges, 1834. Wiedersheim was a leader in the field from 1875-77, then came the extensive monographs of Parker in 1882, Gaup 1898 to 1905, Stadmuller 1914-30, Francis 1934 and a number of others.

Following the terminology of the last, a summary of the condition in the adult salamander may serve as a good introduction to the remarks in various groups.

The primordial skull may be divided into four regions:

1. Ethmoidal. 2. Orbito-temporal. 3. Otic capsules and ear region. 4. Palato-quadrate.

The Ethmoidal Region. This includes especially the nasal capsules whose walls are pierced by a number of large foramina and several large fenestra, and several other important structures as follows:

a) Fenestra basalis nasi. This is in the ventral side covered by the prevomer and a little of the palatine part of the maxillary.

b) Internals nares. These enter the posterior part of the capsule of each side, with the antiorbital cartilage at its caudal side, the ectochoanalis cartilage anteriorly, the cornu trabeculae anterior and the trabecula medial. Fused with the last is the flat cartilaginous plate which connects the olfactory capsules ventrally, called the planum internasale.

c) On the dorsal side of the nasal capsule is the fenestra dorsalis nasi, bounded mesially by the columella ethmoidalis, or dorsal arch of the trabecula; posteriolaterally it is bounded by the oblique cartilage.

d) The fenestra narina surrounds the external nasal opening. Dorsally it is bordered by the oblique cartilage, posteriorly by the retro-narina and anteriorly by the cupullaris cartilages.

e) The fenestra infra-conchalis is posterior to the last, at the extreme postero-lateral angle of the nasal capsule.

f) The fenestra olfactoria is the opening from the cranial cavity for the olfactory nerves.

g) The antrorbital cartilage which separates the nasal capsule from the orbit; the small foramina for deep branches of the fifth cranial nerve; the foramen orbitonasale laterale and mediale.

h) The olfactory capsules are connected together ventrally by a plate of cartilage which projects backwards under the anterior end of the brain, the planum internasale. Between the capsules the space is called cavum internasale where the intermaxillary gland is located.

i) A bridge of cartilage, the tectum internasale unites the capsules dorsally. It is extended anteriorly in the middle line as the rostrum prenasale.

FIGURE 1.

Diagrams showing cartilage elements in the skulls of salamanders. The scale equals 1 mm.

c.a.or.—antrorbital cartilage; c.cup.—cartilage cupullaris; c.ec.ch.—ectochoanalis cartilage; c.o.oc.—occipital condyle; c.op.—operculum; cp.q.—palatoquadrate; c.pl.con.—planum conchale; c.pl.in.—planum internasale; c.t.syn.—tectum synoticum; c.cr.rs.—crista retrosellaris; c.hyp.con.—hypochordal commissure; fen.bc.a.—fenestra basicranialis superior; fen.b.nas.—fenestra basalis nasi; fen.ol.—fenestra olfactoria; fend.d.nas.—fenestra dorsalis nasi; fo.onas.l.—foramina orbitonasalis laterale; fo.op.—foramen opticum; fo.oc.—foramen oculomotor; pr.nas.—nasal process. Cartilage areas shaded.

1-2. Upper and lower views of the skull of *Salamandra* after Parker and Francis. 3. Skull of adult *Cryptobranchus*, below. 4. The same from above, dorsal side. 5. Skull of *Triturus viridescens* from above. 6-7. Skull of *Necturus* below and above. 8. Skull of adult *Amphiuma* from above. 9. Skull adult *Siren*, from above. 10. Skull of adult *Ambystoma*, above. 11. Skull adult *Salamandrella* from above.

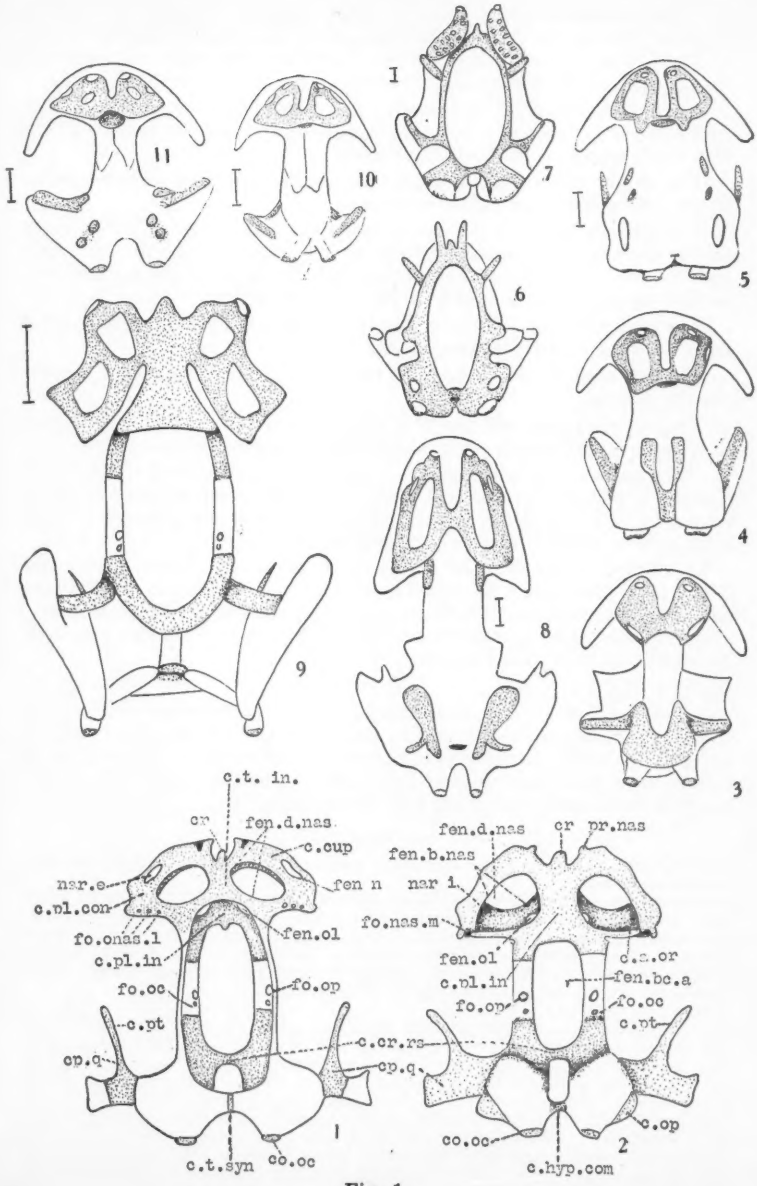
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Fig. 1.

2. The orbito-temporal region. This consists of a pair of vertical lamellae joining the olfactory capsules along the lines of the earlier trabeculae. They are perforated by two foraminia, the larger more cephalic for the optic nerve, the smaller more caudal for the oculomotor nerve.

3. The otic region. This part of the primary skeleton which is at first entirely cartilaginous becomes bone except about the postero-lateral area in the region of the fenestra vestibuli.

The lateral walls of the otic capsules are each attached at three points to the suspensorium or palato-quadrate.

The median walls of the otic capsules are incomplete in early stages and in the adult perforated by four or five foramina as follows: One each for the perilymphatic and endolymphatic ducts of the ear and two or three openings for branches of the auditory nerve.

The cavity of the capsule is partly subdivided by semicircular canal septa which are partly cartilaginous.

The otic capsules are fused with the cranium with traces of the parachordal plates.

The occipital ring and much of the occipital condyles remain largely cartilagenous, but deeper parts attached to the ear capsule are bone.

4. The palato-quadrate region. The suspensorium is attached to the cephalic lateral part of the otic capsule by three processes with cartilage between. The quadrate forms the direct lateral continuation of the basal process and ossifies to a greater or less extent.

Membrane bones close in the skull quite early. They are on the dorsal side: the paired premaxilla, maxilla, nasal, frontal, pre-frontal, parietal and squamosal. On the ventral side: the unpaired median parasphenoid; the paired prevomers and ptergoid with the palatine processes, premaxilla and the paired maxilla.

PROTEIDAE

In *Necturus* of 20 mm total length, the otic capsules are well formed with large openings on the median lateral sides. The notocord extends beyond the basal cartilage; the olfactory capsules have no cartilage as yet; there is little sign of a pre-optic projection; the trabeculae are not broad in front and touch if they do not actually fuse.

FIGURE 2.

Cartilaginous skeletons from immature salamanders. Scale equals one mm, cartilage shaded.
c—cupola; ce—columella ethmoidalis; cep—cephalic process; cp—caudal process; cp—caudal process; ct—cornua trabeculae;en—external nares; cr—circom-oral ring; cc—cavum cranii; t—trabecula; ct—cornu trabeculae; fni—foramen nasalis internis; fen eth.—fenestra ethmoidalis; pa—process antiorbitalis; pv—planum verticale; pt. platum tectale; pb.—planum basale; ins—internasal space; fen.pr.—fenestrated process.
All figures from the dorsal side.
1-3. Nasal capsules of *Salamandra maculosa*, after Higgins. 25 mm, 38 mm and end of matamorphosis. 4. *Triturus torosus* chondrocranium, larva of 22 mm. 5. *T. viridescens* chondrocranium of a larva 11 mm total length. 6. Similar of a 15 mm larva. 8. From a young *Siren* of 60 mm body length. 7. From young *Siren* of 300 total length. 9. *Amphiuma* skull from a specimen of 80 mm total length. 10. Olfactory skeleton of *Cryptobranchus* of three months of age, after Higgins. 11. From *Amphiuma* of 60 mm total length. 12-13. Olfactory skeletons of younger and older *Amphiuma*, after Higgins. 14. Skull of *Necturus* of 20 mm total length. 15-16 *Necturus* olfactory skeletons of 30 and 45 mm, after Higgins.

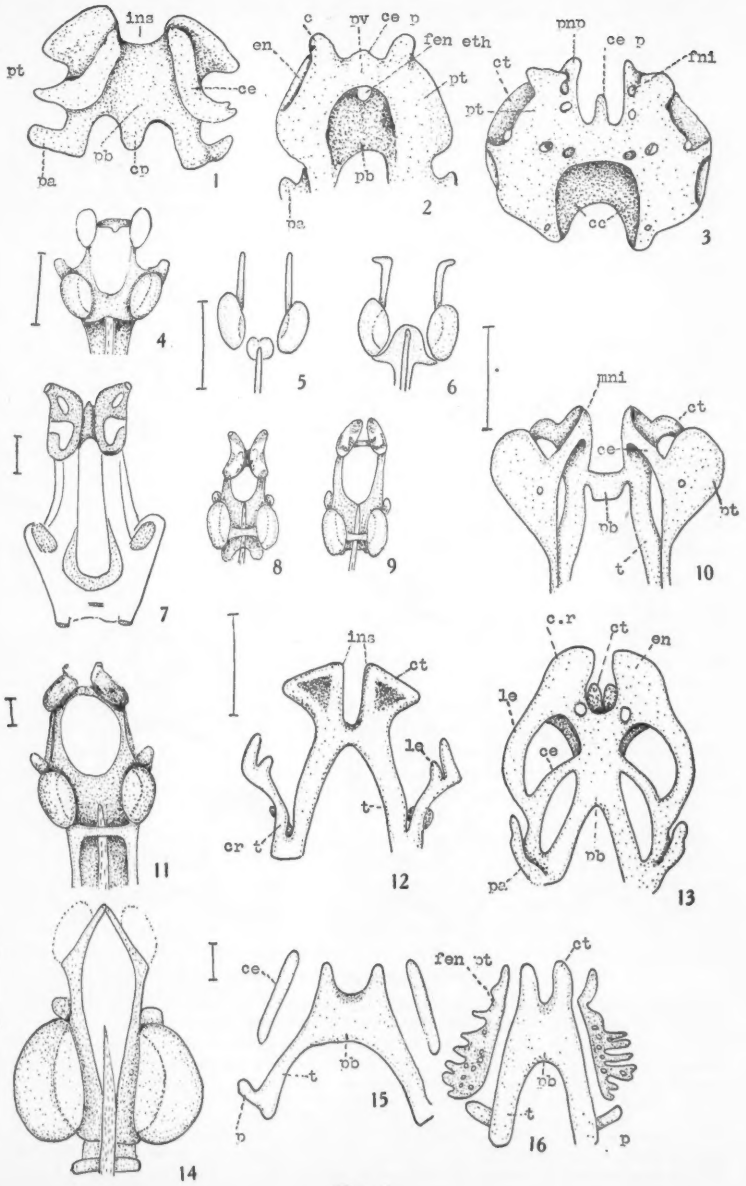
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Fig. 2.

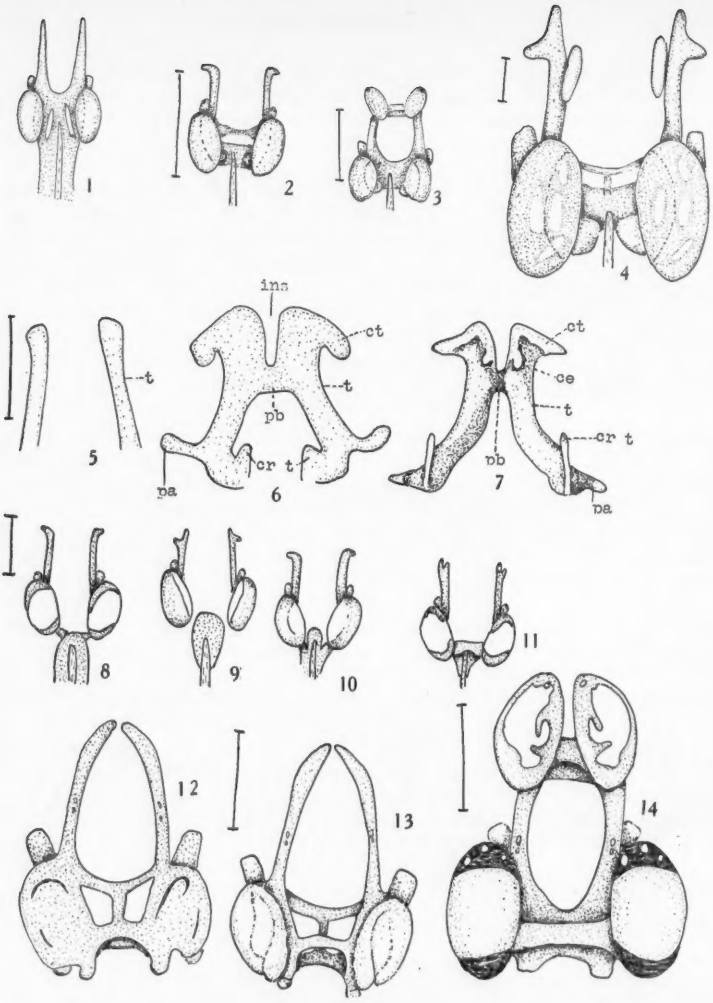

FIGURE 3.

Cartilaginous skeletons of salamander larvae and embryos. Shaded parts cartilage. Scale equals 1 mm. All dorsal side but 12, which is ventral.

1. *Eurecca multiplicata*, 20 mm. 2. *Hemidactylum*, 13 mm. 3. *Plethodon cinereus*, 12 mm. 4. *Manculus*, 28 mm. 5. 6. and 7. Three stages in the olfactory region of *Eurecea bislineata* after Higgins. 5. 15 mm. 6. 37 mm. 7. 46 mm. 8-14. Stages in the development of *Desmognathus*. 8. 10 mm. 9. 12 mm. 10. 17 mm. 11. Late larva. In the last two cartilage is just beginning to form in the otic areas, the median and dorsal sides are not yet cartilage. 12, 13. Lower and upper views of Desmognathus larva of 18 mm. Otic capsule well formed with slight beginnings of bone dorsally and ventrally. 14. From a larva of *D. quadrimaculata* of 35 mm. Otic capsules have bone at cephalic and caudal areas. Olfactory capsules nearly like the adult.

In the nasal region of a 45 mm *Necturus*, the dorsal walls of the olfactory capsules appear as irregular fenestrated plates.

My observations on the adult skull agree in most respects with Wilder '03. The olfactory capsule is quite distinctive. It is not incased in membranous or other bones dorsally and is quite variable in the development of the numerous fenestra on the dorsal side. Cope '89, pictures it quite accurately but rather diagramatically. A structure apparently not noted by Wilder is a median cartilaginous projection between the olfactory lobes. *Necturus* has more cartilage remaining in the ear region of the adult skull than most amphibians. In addition to the strong trabeculae, the well developed platum internasale, the antrorbitals, a large part of the suspensorium and much of the otic capsules are cartilage in the adult.

AMPHIUMIDAE

Hay '90, studied the early stages of *Amphiuma*. In a skull of a specimen of 7 mm total length he shows the trabeculae with a marked cornu extending laterally on each one and a more ventral lateral process more distal to the nasal sac. The otic capsules are oval, the basal cartilage shows foramina for the 5th nerve and on each side of the notocord a large fenestra is indicated.

In a specimen of 60 mm the basal cartilages have more substance and are without fenestra either side of the notocord. The nasal capsule begins to show cartilage in its walls.

In the adult, the olfactory cartilages are extensive. Dorsally the central fenestra is large and oval in outline. The ear region has less cartilage than *Necturus*.

SIRENIDAE

The smallest *Siren* I was able to examine was one of 80 mm total length. In this the otic and olfactory capsules were well developed. The olfactory capsule was not as completely cartilaginous as it becomes later, but it had small regions of cartilage in isolated divisions. In a specimen of 150 mm, the condition was much like that of the adult but with less bone and a larger proportion of cartilage. At this time, the olfactory capsules have two marked fenestra dorsally as in the adult, but of different shape. The dorsal and ventral sides of the auditory capsules have much more bone with little cartilage. There is much cartilage in the suspensorium.

In a large adult of 750 mm total length, cartilage is, rather surprisingly, almost as extensive as in adult Necturus. In the olfactory region there is a prominent median projection joined to a broad central cartilage. Dorsally there are two large fenestra; the ventral ones are not distinctive. There is considerable cartilage in the more caudal regions of the skull and quite a little in the otic capsule, especially in the cephalic region and about the operculum with much in the median wall.

CRYPTOBRANCHIDAE

The youngest stage examined was a larva of 35 mm total length. In this the usual immature condition was found with the olfactory capsules beginning to have areas of cartilage. The dorsal arch in the otic region is well marked but rather narrow. The notocord does not reach the whole length of the basal cartilage.

In an adult of 345 mm total length, with a skull of 42 mm, both the olfactory and otic capsules have much cartilage in their walls. In several specimens examined the dorsal sides of the olfactory capsules lack

large fontanelles. This agrees with Cope's figure in '89. Although the ear region is sheathed in bone much cartilage remains, not only for the dorsal and ventral area but inclosing semicircular canals in part and in the mesial wall.

HYNOBIIDAE

An adult member of the genus *Salamandrella* was examined. This had much less cartilage in the skull than any of the previously mentioned forms, but it resembled *Cryptobranchus* in that the dorsal fontalelle of the olfactory capsules was not marked, although there was some indication of it. Any cartilage in the region is very thin.

There was some cartilage about the opercular region and in the suspensorium.

AMBYSTOMIDAE

Various stages in the development of the cartilaginous cranium have been described in another place, Hilton '50.

In *Ambystoma maculatum* of about 12 to 14 mm, the otic capsules are partly formed as connections between them and the upper end of the notocord are beginning to be established. At first the ends of the trabeculae are pointed, later expanded with each a lateral extension or cornu. A simple condition of the trabeculae may be found in later larvae which are further developed in other respects.

In an *A. tigrinum* of about 145 mm total length, the nasal capsule seems much like the adult, however the otic capsule is largely cartilage with the investing bones beginning to shut it in. Bone is also formed in the operculum and the caudal parts of the trabeculae.

Adults vary greatly in the amount of cartilage that remains. There is usually but little about the ear capsule with some in the median basal region, the opercular areas and the suspensorium.

In *Ambystoma maculatum*, Higgins '20, shows an 11 mm stage with trabeculae not yet united but broadened at the ends. In a 20 mm stage the cartilages are united dorsally with an elongated rod on each side, the columella ethmoidalis.

In a 25 mm stage, the crista trabeculae are better developed and united to the posterior end of the columella ethmoidalis. In this the ethmoidal bridge is developed, the planum tectale is formed, the platum basale is very broad and the process ante-orbitalis is also present.

In a 34 mm larva, the processes developed earlier are all broader. In one of 45 mm the capsule of the nose is complete.

In a specimen of 55 mm the otic capsule has a number of small fontanellae. At the end of metamorphosis the central dorsal fontanelle is very wide.

SALAMANDRIDAE

In a *Triturus torosus* of 11 mm, the otic capsules are well formed but not completely cartilaginous, especially dorsally and mesially. The trabeculae are simple straight rods. The notocord is beginning to have cartilage cells grouped about its upper end. In a specimen of 12 mm there is more cartilage about the end of the notocord and enough to unite with the otic capsules, which last are complete but not entirely cartilage above and towards the middle line. Each trabecula has a cornu at its end.

In a *T. viridescens* of 16 mm, the otic capsules are well formed and joined to the basal cartilage and notocord. The olfactory capsules are well developed and clothed in precartilage.

In a *T. viridescens* of 38 mm, the nasal capsule is much like the adult with the basal plate rather narrow.

In the adult there is the usual large dorsal fontanelle on the dorsal side of the olfactory capsule.

PLETHODONTIDAE

The earliest stage examined of *Desmognathus fuscus* was a larva of 10 mm. This in some respects is more advanced than others that are larger. The notocord does not extend as far as the otic capsules and cartilage about it is connected to the capsules by slender bands. A larva of 12 mm total length is similar to the last with otic capsules more completely cartilaginous, but the cartilage about the end of the notocord has not fused with the capsules. In a late larva not much different in length from the last, the basal cartilage joins the otic capsules. In another the dorsal plate is evident between the capsules, but they are not yet cartilaginous except at the ends. In a specimen of 18 mm the otic capsules are completely cartilaginous with mesial openings; the notocord is not evident, there is ossification in the ear capsules just beginning to show. There are large fenestra in the basal plate between the capsules and the olfactory areas are not yet inclosed in cartilage.

In a specimen of 35 mm, probably a larva of *D. quadrimaculata*, the olfactory capsules are largely cartilage with large, irregular dorsal fenestra, one on each side. The otic capsules are cartilaginous except where bone is formed at cephalic and caudal ends.

In a larval *Eurecea multiplicata* of 17 mm, the notocord reaches to a level about half of the distance forward of the otic capsules. There are foramina each side of the notocord in the basal cartilage.

In a *Hemidactylum* of 13 mm, each trabecula has a cornu and there are dorsal as well as ventral bridges of cartilage between well chondrified olfactory capsules.

In a *Manculus* larva of 28 mm, a more or less typical condition of chondrocranium is found. The olfactory capsules are not sheathed in cartilage, the otic capsules are quite complete except on the mesial surfaces and several dorsal areas.

In a *Plethodon cinereus* of 16 mm, otic and olfactory capsules are well formed, but like the last specimen mentioned above, the dorsal plate between the olfactory capsules is not united across the middle line. In this the olfactory capsules are more complete, in the former the dorsal plate is more nearly formed.

In adults of this family there is quite a variation as to the extent of cartilage in the skull. This depends both on the species and age of the individual. As a rule the conditions are quite typical for salamanders with the usual dorsal fontanelles in the olfactory capsule and in the ear region. In the otic capsule there are differences as to the amount of cartilage that remains. This is usually near the suspensorium about the operculum, internally about some of the semicircular canals of the ear and in the ear capsule on the median side.

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SOME CONCLUSIONS

1. After the study of hundreds of specimens of eight families of salamanders and the examination of thousands of slides of serial sections of larval and adult skulls, the general conclusion is that the chondrocranium develops in much the same way in all the Urodela.

2. Differences between species and genera are in large part due to different periods of embryonic and larval life; some being shorter than others may develop at different rates.

3. More primitive conditions were found in Proteidae and Sirenidae and following them Cryptobranchidae.

4. No evidence was seen of special adaptive structures in particular groups.

Department of Zoology, Pomona College, Claremont, California.

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Pomona College, Claremont, California

DERMAL SENSE ORGANS OF STEREOCHILUS

By WILLIAM A. HILTON

The sense pits of *Stereochilus marginatus* are among the most remarkable of salamanders because of their actual and relatively large size. In a general survey of the lateral line sense organs of Amphibia, this genus among others was considered in 1947. The loan of more abundant material from the U. S. National Museum makes it possible to study these structures more in detail, both in larvae and adults.

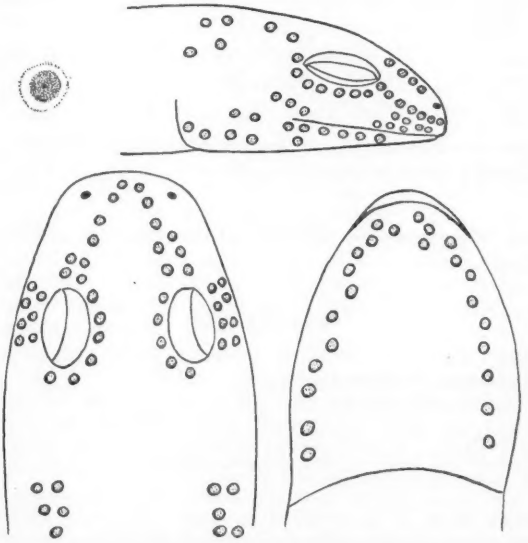

Diagram of the head of adult *Stereochilus marginatus*, from the side, above and below showing the location of the sense pits. Small figure, diagram of a pit from above enlarged more than the other figures.

The Adult.—In the head region the supra-orbitals are similar in number and position in all specimens. There was some variation from the eye to the snout above; from 7 to 10, more often 10. Often one side may have one more organ than the other. The average was 9. The infra-orbitals are usually about 6 on a side of the head from the eye to the snout. On the side from eye to end of the head there may be from 12 to 18 on a side with an average of 13. The post-orbitals are few. The occipital group about four. There are few, as many as three or none above the corner of the mouth on the side of the head. Those under the jaw and throat are about 12 on a side.

These sense organs on the body and tail are not so well developed as on the head, both as to number and size. There is usually a well-marked high dorsal series with one pit to a segment. In some specimens a more ventral row is represented by organs in several segments.

The tail in some cases shows a dorsal line of pits, a continuation of those from the body. Some specimens show a less complete ventral line in addition to the other.

Larval Stages.—A late larval stage was much like the average adult, but smaller specimens did not clearly show the pits. There were many depressions. but it was impossible to tell one kind from another. Some were no doubt sense pits, but much smaller and less conspicuous than those of adults.

Conclusions.—This genus has better marked dermal sense depressions on the head than any salamander. Early larvae may have some of these, but cannot be told from other small skin openings.

The pits are depressed spots, usually about a millimeter or more in diameter with a small pore in the center of a membrane at the bottom of the pit.

Sections show these sense pits to be of the same type as found in other salamanders.

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Pomona College, Claremont, California.

RANGE EXTENSION OF THE CHICKEN TURTLE IN OKLAHOMA

By ROBERT G. WEBB

It seems noteworthy to report a possible range extension of the chicken turtle, *Deirochelys reticularia* (Latreille), in Oklahoma.

Pope states the range in Oklahoma as being confined to "the southeastern tip of Oklahoma." At present there are three specimens in the University of Oklahoma Museum of Zoology from McCurtain, Seminole and Cleveland Counties. The McCurtain County specimen was identified by the Field Museum of Natural History and collected in the summer of 1925. Considering this paucity of data, it still seems probable that this specimen is in the range given above by Pope.

However, the specimens from the two latter counties mentioned extend the range some 180 miles to the northwest and could not conceivably fall within this range. Their data is as follows: (1) UOMZ 10940—collected by Phyllis D. Newport, May, 1931, at Bowlegs, Seminole County, and (2) UOMZ 26988—collected by Dr. A. N. Bragg, May 16, 1950, 15 miles east of Norman, Cleveland County.

Because the records seem quite isolated, it is possible that the specimens were transported by human means to the new locations, also it seems strange that more specimens have not been collected, though this is, no doubt, partly correlated with the nocturnal habits of the animal. Other institutions in Oklahoma were not consulted.

Some facts concerning the possible migration of the two "out of range" individuals into Oklahoma seems relevant. Both localities are in the post oak—blackjack oak association and quite close to Little River, which is one of the many tributaries of the South Canadian River drainage system. Little River occurs approximately one-half mile south of Bowlegs, Seminole County, and the Cleveland County specimen was found within one mile north of Little River. All of the tributaries and waterways in McCurtain County belong to the Red River drainage system. These two drainage systems are separated in the southeastern part of the state by the rugged Kiamichi Mts. and the Ouchita uplift, which would seem to present an effective barrier against the dispersal of *Deirochelys* northwestward from McCurtain County.

Pope reports the range as being the southern coastal plain generally and also from "Prairie County, eastern central Arkansas." It seems probable therefore, that the two specimens new to the state have migrated up the Mississippi River, then west by way of the Arkansas River, through Arkansas and thus into eastern Oklahoma where the Arkansas and South Canadian Rivers unite.

The migration of *Deirochelys* by way of rivers is incongruous with the habits given by Pope, as he states it is "not a river species", but it is possible that the preferable habitat of still water ponds could present itself. The combination of the torrential rains and the easily eroded sandstone in the prairie islands and savannah regions of the post oak-blackjack oak association, has resulted in

the formation of numerous sloughs and ponds, of which the larger are often relatively permanent.

From the data given above, it is my contention that the specimens of *Deirochelys* here reported upon have entered the state of Oklahoma by different routes. Since the Kiamichi and Ouachita Mts. represent an effective dispersal barrier between the two river systems, and the favorable habitats are occasionally afforded by the river itself combined with the action of the rains and subsequent erosion, it is assumed that the McCurtain County specimen has entered the state by way of the Red River drainage system, while the specimens from Cleveland and Seminole Counties have entered through the South Canadian-Arkansas River drainage system.

University of Oklahoma, Norman, Oklahoma.

KINOSTERNON SUBRUBRUM HIPPOCREPIS (GRAY) IN OKLAHOMA*

By HAROLD A. DUNDEE

Two species of mud turtles, genus Kinosternon, are known to occur in Oklahoma. One, *K. f. flavescens* (Agassiz), is abundant in ponds, ditches, borrow pits, etc. in the prairie regions of the western half of the state. The other, *K. subrubrum hippocrepis*, has heretofore been reported only twice; from Tulsa County (Ortenburger, 1926), and McCurtain County (Burger, et al., 1949). Force (1930) and Pope (1939) mentioned the former record.

No catalog number was given by Ortenburger for the Tulsa County specimen, but it was listed as being in the University of Oklahoma Museum of Zoology. In the ensuing search for this specimen it was found that the turtle had a number duplicate to that alloted to a snake. This discrepancy apparently occurred due to the lack of printed numbered tags in the early days of the museum. Since the snake was entered in the catalog and the turtle unlisted, the turtle record should be deleted. This leaves only the McCurtain County record for the state.

The University of Oklahoma Museum has several other specimens which extend the range of *hippocrepis* in Oklahoma. These include UOMZ 12410 from Okmulgee County; 11710, 11794, 8087 from vicinity of Wilburton, Latimer County, 25336 from 17 miles south of Lehigh, Coal County, 25350-25352 from 3 miles southeast of Tom, McCurtain County; 25975 from Mayes County, and 15937 from 1½ miles east of Zoe, Le Flore County. At the Oklahoma A. and M. College Museum of Zoology there is a specimen, T-25, from McCurtain County and T-29, from Milburn Johnston County.

*Contribution of the University of Oklahoma Museum and the Oklahoma Biological Survey.

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In this area, at least, I believe that the confusion of *flavescens* and *hippocrepis* can be avoided by determination of the following major differential characters:

K. f. flavescens—Western in distribution. The 9th marginal shield is distinctly higher than the 8th and is roughly triangular in shape. The underside of the head and neck are bright yellow. The 10th marginal is also enlarged.

K. s. hippocrepis—Mainly southeastern in distribution. The 9th marginal shield is about the same height as the eighth. The 10th marginal is enlarged. The head is mottled and has two laterally placed yellow stripes.

Lesser differences are the darker plastron and usually narrower anterior vertebral shield of *hippocrepis*. The latter is also a smaller turtle.

Juveniles of *flavescens* do not have the enlarged 9th marginal. However, the head and neck markings are as in the adults. Young *hippocrepis* have three fairly distinct longitudinal keels on the carapace while *flavescens* has only a faint median keel.

On June 23, 1948, observation was made on the habits of *hippocrepis* during drought. In southeastern McCurtain County three specimens were secured from decaying logs bordering a dried swamp. The remains of dead specimens of the thoroughly aquatic *Amyda* and *Pseudemys* were common on the mud left in the swamp. It appears that *hippocrepis* is more resistant to desiccation during drought.

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Department of Zoology, University of Kansas, Lawrence, Kansas.

THE EGGS OF *ACRIS GRYLLUS CREPITANS* BAIRD

By ROBERT L. LIVEZEY

The herpetological literature of the past does not record any adequate description of the eggs of *Acris g. crepitans*. The present author previously (1947) summarized the available information on eggs of this form and stated that they appeared to be identical with the eggs of *Acris g. gryllus*. From the following observations it will be noted that the statement was in error. Smith (1934) gives the egg as having one gelatinous envelope, over 2.3 mm. but not over 7.5 mm. in diameter (this seems to be an extremely wide range). He also remarks that they are laid singly or in small masses.

Three amplexing pairs of *Acris* were collected at Nelson Creek, Walker County, Texas, the evening of July 6, 1949. These were taken to the laboratory and placed in large aquaria provided with water, sand, and debris from the creek. During the night one female deposited several dozen eggs. These were laid singly and in small, irregular clusters containing two to seven eggs. Pine needles, twigs, grass stems, and leaves were utilized as places for deposition; several single eggs were also found on the sand in the bottom. In the small masses the eggs were held

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together by the adhesion of the gelatinous envelopes. Individual eggs were distinct in the mass, but the single egg or cluster shortly becomes difficult to discern as a result of the large amount of debris which sticks to the viscid jelly.

Vitelli of the eggs were dark brown to black above and tan below, with an average diameter of 1.13 mm., the range being 1.06 to 1.17 mm. The vitelline capsule was closely applied to the vitellus and visible, in the unsegmented stage, only at the animal pole. Examination with a binocular microscope revealed the presence of two gelatinous envelopes (Figs. 1 and 2). The inner was indistinct and not visible without optical aid, but the outer was quite distinct and firm. Measurements of these envelopes were: inner 2.34 - 2.74 mm., average 2.60 mm.; outer 2.98 - 3.70 mm., average 3.34 mm. From these data it is indicated that the eggs of *Acris g. crepitans* differ from those of *Acris g. gryllus* (providing published data on the latter are accurate). The former sub-species apparently has a somewhat larger vitellus, two envelopes rather than one, and the average overall diameter is slightly greater. This last criterion may, however, be a matter of samples examined.

Diagram of Egg. Broken line indicates indistinctness of envelope. 5x.

Wright and Wright (1949, pp. 37 and 219) give 241 and 250 eggs as the complement for *Acris g. gryllus*. Ovarian counts indicate that *Acris g. crepitans* may have a larger complement of eggs per female than its south-eastern relative. A gravid female taken April 12, 1947 from south of Huntsville, Walker County Texas, contained 125 fully developed and about 100 vitelli in formative stages in the left ovary. Another specimen collected April 26, 1947 from the Brazos River, Palo Pinto County, contained a total of 315 eggs (192 in the right and 123 in the left ovary). A third ovarian count of a female collected at Huntsville, April 10, 1948, totaled 340 eggs (169 in the right and 171 in the left ovary). There was no difference in size or appearance of the eggs from the Walker County and the Palo Pinto County specimens.

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In Texas the active season of these abundant little hylids is extensive. Depending upon the weather, they may be seen any month of the year. Personal field notes record choruses from February until October. However, the latter part of April through July seems to represent the peak of the breeding season.

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